Prevalence of HIV Infection Among Inpatients and Outpatients in Department of Veterans Affairs Health Care Systems: Implications for Screening Programs for HIV

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Objectives. We sought to determine the prevalence of HIV in both inpatient and outpatient settings in 6 Department of Veterans Affairs (VA) health care sites.

Methods. We collected demographic data and data on comorbid conditions and then conducted blinded, anonymous HIV testing. We conducted a multivariate analysis to determine predictors of HIV infection.

Results. We tested 4500 outpatient blood specimens and 4205 inpatient blood specimens; 326 (3.7%) patients tested positive for HIV. Inpatient HIV prevalence ranged from 1.2% to 6.9%; outpatient HIV prevalence ranged from 0.9% to 8.9%. Having a history of hepatitis B or C infection, a sexually transmitted disease, or pneumonia also predicted HIV infection. The prevalence of previously undocumented HIV infection varied from 0.1% to 2.8% among outpatients and from 0.0% to 1.7% among inpatients.

Conclusions. The prevalence of undocumented HIV infection was sufficiently high for routine voluntary screening to be cost effective in each of the 6 sites we evaluated. Many VA health care systems should consider expanded routine voluntary HIV screening. (*Am J Public Health.* 2007;97:2173–2178. doi:10.2105/AJPH.2007.110700)

Early identification of HIV infection through screening substantially lengthens the life of the person identified and provides an important public health benefit from reduced HIV transmission.[1] HIV screening in health care settings is also cost effective, even when the prevalence of HIV infection is as low as 0.05% to 0.1%.[1–3] Newly revised guidelines for HIV screening from the Centers for Disease Control and Prevention (CDC) recommend one-time screening in all health care settings unless the prevalence of undiagnosed HIV infection is documented to be less than 0.1%.[4]

The prevalence of undiagnosed HIV infection has been documented in few health care settings in the era of highly active antiretroviral therapy. The Sentinel Hospital Study, which assessed HIV prevalence in a probability sample of nonfederal US hospitals, showed that the prevalence of HIV infection ranged from 0.1% to 7.8% among sentinel hospital populations (inpatients and outpatients combined) in 1989; however, currently, few people with HIV are hospitalized, so both inpatient and outpatient prevalence rates may differ from previous estimates. Although total HIV prevalence has been evaluated in many settings, the most important factor in determining the usefulness of an HIV screening program is the prevalence of unidentified, rather than known, HIV infection.

The preferred method for determining an unbiased estimate of prevalence in a population is a blinded (anonymous) serological survey, an approach recommended by the CDC.[6,7] In a blinded serological survey, blood that is drawn for other purposes is stripped of identifiers and tested for HIV. Because the patient's identity cannot be determined, informed consent is not required. Other approaches that depend on patients' acceptance of screening are limited by selection bias that occurs when patients decline testing.[8–10] This selection bias can be substantial, and the prevalence of HIV among patients who have declined testing may be either higher or lower than the prevalence among patients who accept testing.[11] Blinded serological surveys have been used widely, most notably in the Sentinel Hospital Study.[5]

We conducted a blinded serological survey to determine the prevalence of HIV infection among outpatients and inpatients in 6 Department of Veterans Affairs (VA) health care systems. The VA is one of the largest integrated health care systems and the largest provider of HIV care in the United States. Our goal was to assess the prevalence of both documented and undocumented HIV infection and to assess demographic and clinical predictors of documented and undocumented infection. Although predictors of undocumented HIV infection have been evaluated in emergency departments,[12,13] they have not been well studied in VA populations.

METHODS

Site Selection

We conducted our study as part of the HIV Quality Enhancement Research Initiative within the VA. The VA has more than 157 hospitals and 887 outpatient clinic facilities nationwide; documented HIV prevalence at these facilities varies widely, from a low of 0.01% to a high of 1.85%.[14] We selected 6 VA facilities in which to conduct the survey. The 6 sites, selected to represent the range of documented HIV prevalence within the VA, were located in urban areas and served from 17 163 to 58 723 patients per year. The race/ethnicity distribution of these patients varied across sites (African Americans, 12%–42%; Whites, 9%–60%).

Each of the sites was affiliated with an academic institution and had an active HIV clinical program ranging in size from 80 to more than 1000 patients with HIV. We selected sites in part on the basis of whether they had the research infrastructure necessary to perform the study. Blood specimens and data were collected from the sites from December 2000 to October 2002. Specimens were collected over a period of at least 6 weeks at each site.

Sampling Strategy

The CDC guideline recommends that 1000 blood specimens be tested in blinded serological surveys.[7] We increased this number to 1500 per VA site so that we could assess prevalence rates among both inpatients and outpatients. We chose our sample size to yield reasonable precision for our estimates of HIV prevalence given the resources we had for testing. In the case of a sample of 750 specimens, the 95% confidence interval (CI) would be 0.4% to 1.9% if the true prevalence was 1% and 0% to 0.7% if the true prevalence was 0.1%. We calculated CIs using exact binomial distributions.

We used a sampling scheme such that the specimens collected represented the age distribution of the patient population at each site. Each site provided data on the age distribution of all patients for the period from October 1, 1998, to September 30, 1999. Because the age distribution of the patient population is higher among the VA population than it is among the general population, we collected specimens from patients 25 years and older. Age groups were divided into 5 categories (25–44, 45–54, 55–64, 65–74, and 75 years or older). We collected at least 10% more than the required number of specimens for each age group according to the CDC recommendations to oversample each age group.[7]

Blood Specimen Selection and Data Collection

We obtained blood specimens separately for inpatients and outpatients. To be included, a specimen had to be viable (e.g., not grossly hemolyzed), and a sufficient surplus of serum or plasma (at least 0.2 mL) had to be available; also, patients were required to be veterans and to fit into 1 of the defined age strata. If the specimen fit the inclusion criteria and was unique according to its identification number, it was collected. Each specimen represented a unique patient. We continued specimen collection until the required numbers of specimens for all (inpatient and outpatient) age groups had been obtained, with 1 exception. At 3 sites, an insufficient number of inpatient specimens was available for the age group 25–44 years, and thus we discontinued specimen collection in this stratum at these sites even though the required number of specimens had not been collected.

We derived demographic and clinical information from electronic medical records. We did not collect data on gender, because there were too few women to ensure anonymity, even with all identifiers removed. On the basis of other studies of the VA population, we estimated that men made up more than 95% of our sample. Furthermore, at these sites, only 1% to 2% of patients with known HIV infection were women. We collected data on ethnicity, comorbid conditions, and whether the patient had been tested previously for HIV within the VA system. Comorbid conditions assessed included Alzheimer's disease; cerebrovascular disease; chronic liver disease or cirrhosis; chronic obstructive pulmonary disease; diabetes; diseases of the heart; hepatitis B, C, or D; malignant neoplasms; nephritis; pneumonia or influenza; psychiatric conditions; septicemia; and sexually transmitted diseases.

We based whether or not patients had previous knowledge regarding their HIV status on documentation in their medical record of previous HIV testing at a VA medical center. We were not able to determine whether patients had been tested for HIV outside of the VA system. Documentation of previous HIV testing could include either an *International Classification of Diseases, Ninth Revision*,[15] code for AIDS diagnosis (0.42) or an HIV antibody test result. We did not use surrogate measures, such as CD4 counts, to identify patients who had HIV, because of the potential for misidentification of the infection. On completion of specimen and data collection, all identifying information that had been used in selecting specimens and collecting data was destroyed so that there were no data linking individual patients to the specimens selected.

Blood Specimen Testing

We tested blood specimens at the AIDS Research Center laboratory at the VA Palo Alto Health Care System after all identifying information had been removed. Because there were at least 10% more specimens collected than were required for the survey, we randomly selected specimens for testing from those we had collected. We used a standard HIV-1 enzyme immunoassay test kit to test all specimens individually. Specimens that were positive underwent repeat enzyme immunoassay testing, and those positive after repeat testing underwent an HIV-1 Western blot confirmatory test.

HIV-1 enzyme immunoassay (Organon Teknika, Bio Merieux Corp, Oklahoma City, Okla) and Western blot (Calypte Biomedical Corp, Alameda, Calif) tests were performed according to the manufacturers' instructions. Samples shown to be negative according to enzyme immunoassay tests did not undergo further testing and were defined as negative. We defined samples as positive if they were positive according to both enzyme immunoassay and Western blot testing. Samples positive according to enzyme immunoassay testing and indeterminate according to Western blot testing were defined as indeterminate.

Data Analysis

In calculating prevalence rates of HIV infection, we used the number of total HIV-positive specimens at each of the 6 sites as the numerator and the total number of unique patients seen during the study period as the denominator. We defined undocumented HIV prevalence as the number of HIV-positive cases among patients with a previously documented negative or unknown test result. We conducted logistic regression analyses to determine predictors of documented and undocumented HIV infection. We included the following independent variables in the model: inpatient or outpatient status, age group, site, race/ethnicity, and all of the earlier-listed comorbid conditions. We used EPI Info 6.03c software[16] and SAS version 8.0 (SAS Institute, Cary, NC) to analyze the data.

RESULTS

We collected a total of 11 125 unique blood specimens: 6024 outpatient specimens and

5111 inpatient specimens. We tested 8705 specimens: 4500 unique outpatient specimens and 4205 unique inpatient specimens. Between 52% and 71% of tested patients were between the age of 25 and 64 years, depending on the site in question (Table 1). The patients were predominantly White, with high rates of hepatitis C virus infection and other comorbid conditions (Table 1) compared with national prevalence rates.

TABLE 1—Demographic Characteristics of Tested Patients, by Site: Department of Veterans Affairs Health Care Systems, 2000–2002

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Total sample, no.	1500	1500	1396	1430	1500	1379
Age group, y, %						
25–44	16	11	23	16	21	18
45–54	28	23	29	24	25	28
55–64	17	18	19	16	15	13
65–74	21	22	16	23	22	21
≥75	18	27	13	21	18	20
Race/ethnicity, %						
White	61	62	56	41	45	66
African American	11	19	14	30	36	27
Hispanic	6	5	6	13	0.2	2
Other	4	6	4	1	0.3	0.2
Unknown	18	8	20	15	19	5
History of hepatitis C, %	9	13	11	14	6	7
History of hepatitis B, %	1	3	3	2	0.004	1
Comorbid conditions, %[a]	86	91	87	73	55	80

Note. As a result of rounding, percentages may not sum to 100.
[a] Comorbid conditions included Alzheimer's disease; cerebrovascular disease; chronic liver disease or cirrhosis; chronic obstructive pulmonary disease; diabetes; diseases of the heart; hepatitis B, C, or D; malignant neoplasms; nephritis; pneumonia or influenza; psychiatric conditions; septicemia; and sexually transmitted diseases.

Documented HIV Infection

Of the 8705 blood specimens tested, 326 (3.7%) were HIV positive. Outpatient HIV prevalence rates ranged from 0.9% to 8.9%, and inpatient rates ranged from 0.8% to 6.9% (Table 2). Overall, outpatient HIV prevalence (4.3%) was significantly higher than inpatient HIV prevalence (3.1%; odds ratio [OR]=1.39; 95% CI=1.08, 1.78; $P<.05$). HIV prevalence was highest (11.4%) among outpatients aged 25 to 44 years but was also substantial (3.5%) among outpatients aged 55 to 64 years (Table 3). HIV prevalence rates were higher among African Americans and Hispanics than among other ethnic groups and were much higher in patients who had hepatitis C infection (Table 3). In a multivariate logistic regression model, significant predictors of previously documented HIV infection were younger age, African American race, outpatient status, and having a history of hepatitis B, hepatitis C, a sexually transmitted disease, or pneumonia (Table 4).

Undocumented HIV Infection

Of the 326 blood specimens shown to be HIV positive in anonymous testing, 273 were collected from patients with a previous positive HIV test result, 5 were collected from patients

TABLE 2—HIV Test Results, by Site: Department of Veterans Affairs Health Care Systems, 2000–2002

	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient	Inpatient
No. tested	750	750	750	750	750	646	750	680	750	750	750	629
No. HIV positive	17	9	31	33	60	20	67	47	12	18	7	5
No. previously tested	171	216	198	182	242	238	156	108	31	73	91	167
No. previously HIV positive	15	9	29	32	62	20	57	40	7	11	6	6
HIV prevalence, % (95% CI)	2.27	1.20	4.13	4.40	8.00	3.09	8.93	6.91	1.60	2.40	0.93	0.79
	(1.3, 3.6)	(0.6, 2.3)	(2.8, 5.8)	(3.0, 6.1)	(6.2, 10.2)	(1.9, 4.7)	(7.0, 11.2)	(5.1, 9.1)	(0.8, 2.8)	(1.4, 3.8)	(0.4, 1.9)	(0.3, 1.8)
Undocumented HIV prevalence,[a] % (95% CI)	0.27	0	0.28	0.14	0.29	0	2.81	1.69	0.67	1.07	0.13	0.16
	(0.03, 0.98)		(0.03, 1.0)	(0.00, 0.77)	(0.04, 1.04)		(1.7, 4.3)	(0.85, 3.0)	(0.22, 1.55)	(0.46 2.1)	(0.00, 0.75)	(0.00, 0.89)
Proportion of prevalence categorized as unidentified[b]	0.11	0	0.06	0.03	0.03	0	0.31	0.24	0.41	0.44	0.13	0.20
Total site HIV prevalence, %[c]	1.73		4.27		5.73		7.97		2.0		0.87	
Total site undocumented HIV prevalence, %	0.14		0.21		0.15		2.27		0.87		0.15	

Note. CI = confidence interval.
[a] Percentage of positive HIV tests among those with a previous HIV-negative or unknown test result.
[b] Calculated with undocumented HIV prevalence as the numerator and HIV prevalence as the denominator.
[c] Total number of HIV-positive results divided by total number of patients tested.

TABLE 3—Prevalence of HIV Infection, by Selected Characteristics: Department of Veterans Affairs Health Care Systems, 2000–2002

	Total HIV Prevalence		HIV Prevalence Among Patients With Previous Unknown Test Results	
	Outpatient, % (95% CI)	Inpatient, % (95% CI)	Outpatient, % (95% CI)	Inpatient, % (95% CI)
Total	4.3 (3.7, 4.9)	3.1 (2.6, 3.7)	0.7 (0.5, 1.0)	0.5 (0.3, 0.8)
Age group, y				
25–44	11.4 (9.3, 13.7)	5.9 (4.2, 8.1)	1.6 (0.8, 2.7)	0.8 (0.3, 2.0)
45–54	5.6 (4.4, 7.2)	5.2 (4.0, 6.6)	0.9 (0.4, 1.6)	0.6 (0.3, 1.3)
55–64	3.5 (2.3, 5.2)	2.8 (1.7, 4.3)	0.7 (0.2, 1.7)	0.9 (0.3, 1.9)
65–74	0.8 (0.4, 1.6)	1.3 (0.6, 2.3)	0.5 (0.2, 1.2)	0.4 (0.1, 1.0)
≥75	0.1 (0.0, 0.6)	0.2 (0.0, 0.9)	0.1 (0.0, 0.6)	0.0 (0.0, 0.4)
Race/ethnicity				
African American	7.4 (5.8, 9.2)	6.2 (4.9, 7.9)	1.2 (0.6, 2.2)	1.4 (0.8, 2.4)
White	3.3 (2.6, 4.1)	2.1 (1.5, 2.7)	0.3 (0.1, 0.6)	0.3 (0.1, 0.6)
Hispanic	11.5 (7.6, 16.5)	3.3 (1.4, 6.4)	1.0 (0.1, 3.7)	0.0 (0.0, 1.6)
Other	0.9 (0.0, 4.9)	1.8 (0.2, 6.2)	0.0 (0.0, 3.4)	0.0 (0.0, 3.3)
Unknown	2.2 (1.3, 3.5)	1.8 (0.7, 3.7)	1.4 (0.7, 2.5)	0.0 (0.0, 1.0)
History of hepatitis C				
Yes	12.0 (9.1, 15.4)	11.2 (8.4, 14.6)	0.8 (0.2, 2.3)	1.3 (0.4, 3.0)
No	3.5 (2.9, 4.1)	2.2 (1.8, 2.7)	0.6 (0.3, 0.9)	0.3 (0.1, 0.6)

Note. CI = confidence interval.

with a previous negative test result, and 48 were collected from patients with no previous VA-documented HIV test result. Therefore, 53 (48 involving no test result and 5 involving a previously negative test result) of the 326 specimens that were positive had not been previously identified within the VA system. The prevalence of HIV infection not previously documented within the VA system was lower than the total HIV prevalence, ranging from 0.0% to 1.7% among inpatients and from 0.1% to 2.8% among outpatients (Tables 2 and 3). At 2 of our sites, we found no cases of undocumented HIV infection among inpatients (Table 2).

In comparison with patients known to have HIV, patients who had undocumented HIV infection were more likely to be older (aged more than 55 years; $P=.006$) and less likely to have comorbid conditions (OR=0.3; 95% CI=0.15, 0.60; $P<.001$). The percentage of HIV infections that had not been documented within the VA system varied substantially between sites from 3% to 44% (Table 2). Significant predictors of undocumented HIV infection were age, race/ethnicity, site, and history of pneumonia (Table 4).

Indeterminate HIV Test Results

Among the 8705 blood specimens we tested, 77 (0.88%) had an indeterminate result according to Western blot (defined on the basis of the package insert in the testing kit). After reviewing the specific banding patterns of these specimens, we determined that 23 of 77 (30%) specimens had patterns suggestive of acute HIV infection on the basis of historic studies of the "characteristic evolution of the Western Blot banding pattern" (data not shown).[17(p89)] We did not perform HIV viral load testing to confirm the possibility of acute infection. There were also significantly more indeterminate specimens from inpatients than from outpatients (47 vs 30; $P<.05$).

DISCUSSION

We used an anonymous serological survey involving more than 11 000 specimens to evaluate the prevalence of HIV infection in 6 inpatient and 6 outpatient settings in a sample of geographically diverse VA health care sites. The prevalence of HIV in health care settings is important because it is a key determinant of the usefulness of HIV screening. The need for expanded screening for HIV has become clear as compelling evidence has accumulated that the current approach to identifying HIV infection has substantial limitations.

According to CDC surveillance data, approximately 40% of patients diagnosed with HIV develop AIDS within a year.[1] Evidence from the VA indicates that approximately 40% of patients have CD4 counts below 200/mm^3 when they are diagnosed.[18] These data indicate that close to half of patients have had HIV infection for many years before their diagnosis. In addition, risk-based screening, in which risk assessment precedes a decision to test for HIV, fails to identify a large proportion of people with HIV.[19–21] This evidence has led the CDC to develop new guidelines that recommend one-time HIV screening in all health care settings unless the prevalence of undiagnosed HIV has been documented to be less than 0.1%.[4]

We found that the prevalence of undocumented, and probably undiagnosed, HIV infection varied from 0.14% to 2.27% (inpatient and outpatient samples combined) at our 6 sites. The overall prevalence of HIV (including both documented and undocumented HIV infection) was substantially higher, as expected. We also found that prevalence of HIV infection was higher among younger veterans and those with evidence of sexually transmitted diseases, pneumonia, and hepatitis B or C. Sexually transmitted infections and hepatitis are, in all likelihood, markers for unobserved risk behaviors. Of note, patients who had undocumented HIV infection were more likely to be older than 55 years than were patients who had documented HIV infection and they were less likely to have comorbid conditions. These findings underscore the importance of considering the possibility of HIV infection in older patients.

A second important finding was that outpatient prevalence was higher than inpatient prevalence, probably a reflection of the fact that patients with HIV are seldom hospitalized. The only settings in which we did not find the prevalence of undocumented HIV to be greater than 0.1% were the inpatient services at 2 sites. This result should be interpreted cautiously, however, given that our sample was not of a sufficient size to exclude

TABLE 4—Predictors of Documented and Undocumented HIV Infection: Department of Veterans Affairs Health Care Systems, 2000–2002

	Documented HIV Infection		Undocumented HIV Infection	
	AOR[a] (95% CI)	*P*	AOR[b] (95% CI)	*P*
Age group, y		<.01		.01
25–44	1.76 (1.32, 2.35)		1.56 (0.77, 3.14)	
45–54 (Ref)	1		1	
55–64	0.71 (0.49, 1.04)		1.05 (0.48, 2.31)	
65–74	0.26 (0.15, 0.44)		0.54 (0.23, 1.27)	
≥75	0.04 (0.01, 0.12)		0.07 (0.01, 0.53)	
Site		<.01		<.01
Site 1	0.45 (0.27, 0.73)		0.56 (0.09, 3.40)	
Site 2 (Ref)	1		1	
Site 3	1.02 (0.70, 1.50)		0.51 (0.09, 3.10)	
Site 4	1.98 (1.38, 2.86)		9.41 (2.82, 31.38)	
Site 5	0.45 (0.28, 0.73)		2.89 (0.80, 10.43)	
Site 6	0.19 (0.10, 0.36)		0.57 (0.09, 3.50)	
Race/ethnicity		<.01		.03
African American	1.83 (1.38, 2.43)		2.57 (1.30, 5.06)	
White (Ref)	1		1	
Hispanic	1.25 (0.79, 1.96)		0.64 (0.14, 2.91)	
Other	0.38 (0.11, 1.29)		<0.001 (<0.001, >999.9)	
Unknown	0.61 (0.39, 0.96)		2.37 (1.07, 5.26)	
Outpatients, (Ref = inpatients)	1.39 (1.08, 1.78)	.02	1.30 (0.73, 2.33)[c]	.37
History of disease				
Hepatitis C	1.89 (1.40, 2.55)	<.01	1.05 (0.47, 2.36)[c]	.91
Hepatitis B	1.76 (1.05, 2.95)	.47	0.79 (0.10, 6.27)[c]	.83
Sexually transmitted disease	6.07 (4.22, 8.72)	<.01	1.05 (0.14, 7.87)[c]	.96
Pneumonia	4.83 (3.39, 6.88)	<.01	2.98 (1.1, 8.02)	.03

Note. AOR = adjusted odds ratio; CI = confidence interval.
[a]Adjusted for age, site, race/ethnicity, and history of hepatitis B, hepatitis C, sexually transmitted disease, and pneumonia.
[b]Adjusted for age, site, race/ethnicity, and history of pneumonia.
[c]Not significant at $P < .05$ and thus not included in forward stepwise model.

a prevalence above 0.1% and a single case of undocumented HIV infection would have resulted in a prevalence above the 0.1% threshold.

We could not determine whether patients who had undocumented HIV infection had been tested outside the VA system. It is therefore possible that some of the patients we found to have undocumented HIV infection may have known of their HIV status. In our experience, however, it is rare for patients not to disclose that they have HIV, because the VA provides comprehensive care for the disease.

Two sites reported higher proportions of undocumented HIV infection than did other sites. We do not know whether these differences were related to the patient population or to local practices regarding testing and documentation of test results. Further evaluation of these issues is an important area for additional research.

We also found that 0.88% of all specimens tested had indeterminate Western blot results on the basis of the interpretation provided by the manufacturer. Of these specimens, one third had Western blot band patterns suggestive of acute HIV infection, raising the possibility that hospital admission may have been associated with an acute retroviral syndrome. Thus, our documented prevalence may be an underestimate given the possibility that some patients with indeterminate Western blot test results may have had acute HIV infection.

Implications for Screening

Is the prevalence of HIV infection sufficient to warrant screening for HIV in the settings we evaluated? Our recent evaluation of the cost effectiveness of HIV screening[1] indicates that screening would be cost effective even when prevalence is as low as 0.05%, or 1 in 2000. Thus, our prevalence findings strongly indicate that screening would be cost effective in the settings we evaluated, with the possible exception of 2 inpatient settings. However, a much larger sample size would be needed in these inpatient settings to demonstrate convincingly that the prevalence was less than 0.05%, or even the 0.1% used in the CDC guideline. Approximately 3690 samples with no positive results would be required for the upper bound of the 95% CI to be less than 0.1%, and 7380 samples would be required for the upper bound to be less than 0.05%. Given our sample size limitations, we believe that our findings provide support for screening in all of the settings we evaluated.

An important question is whether our findings can be generalized to other settings. Our study was performed only in VA health care facilities, and the patients tested were overwhelmingly men. We chose our 6 VA sites to represent diversity in terms of location and different strata of documented HIV prevalence according to preexisting data. However, all of our centers were located in urban areas, and 5 were relatively large centers, with the sixth being medium in size. Practical considerations precluded us from using a probability sample of VA settings. However, we believe that our sample of sites represents a diverse group within the VA system that is probably representative of many urban VA centers.

The demographics of the VA system differ from those of other health care systems, and therefore our findings may not apply to other care settings. Although there are few recent estimates of the prevalence of undiagnosed HIV infection in general health care settings, a recent blinded serological survey conducted in an academic medical center[22] revealed that the prevalence of undiagnosed HIV in general medicine and trauma services ranged from 1.4% to 3.7%. This result suggests that the prevalence in other settings may be higher than the prevalence we found.

As mentioned, the new CDC guideline recommends screening in health care settings unless the prevalence of HIV has been documented to be less than 0.1%.[4] Although our results cannot necessarily be generalized to other settings, it should be noted that because blinded serological studies are expensive and logistically difficult, it would not be surprising if few other settings are able to document their HIV prevalence rates, particularly rates of undiagnosed HIV infection. In the absence of data specific to other settings, our results provide information that may be helpful to decisionmakers.

Conclusions

Current approaches to identifying HIV infection have failed to diagnose up to half of patients until late in the course of AIDS. Our findings, along with analyses of the cost effectiveness of HIV screening,[1,2] indicate that the prevalence of undocumented HIV is sufficiently high that routine screening for the disease is warranted in the health care settings we evaluated. ■

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Contributors

D.K. Owens originated and supervised the study and led the writing of the article. V. Sundaram supervised the study, collected data and specimens, completed the analyses, and participated in the writing. L.C. Lazzeroni assisted with the study and the analyses. L.R. Douglass assisted with data abstraction, specimen collection, and data management. G.D. Sanders assisted with the analyses and reviewed and commented on the article. K. Taylor, V.M. Shadle, T. Agoncillo, J. Nyland, and P. Tempio assisted with the study and the analyses and reviewed and commented on the article. R. VanGroningen, V.C. McWhorter, N. Haren, W. Khayr, D.J. Dietzen, P. Jensen, M.S. Simberkoff, S.A. Bozzette, and M. Holodniy supervised the study and reviewed and commented on the article.

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Human Participant Protection

This study was approved by the Stanford University institutional review board, the institutional review boards at the participating sites, and the Veterans Affairs Office of General Counsel.

References

1. Sanders GD, Bayoumi AM, Sundaram V, et al. Cost-effectiveness of screening for HIV in the era of highly active antiretroviral therapy. *N Engl J Med.* 2005;352:570–585.

2. Paltiel AD, Weinstein MC, Kimmel AD, et al. Expanded screening for HIV in the United States—an analysis of cost-effectiveness. *N Engl J Med.* 2005;352:586–595.

3. Paltiel A, Walensky R, Schackman B, et al. Expanded HIV screening in the United States: effect on clinical outcomes, HIV transmission, and costs. *Ann Intern Med.* 2006;145:797–806.

4. Branson BM, Handsfield HH, Lampe MA, et al. Revised recommendations for HIV testing of adults, adolescents, and pregnant women in health-care settings. *MMWR Recomm Rep.* 2006;55(RR-14):1–17.

5. St. Louis ME, Rauch KJ, Petersen LR, Anderson JE, Schable CA, Dondero TJ. Seroprevalence rates of human immunodeficiency virus infection at sentinel hospitals in the United States. *N Engl J Med.* 1990;323:213–218.

6. Centers for Disease Control and Prevention. Revised guidelines for HIV counseling, testing, and referral. *MMWR Recomm Rep.* 2001;50(RR-19):1–57.

7. Schwartlander B, Janssen RS, Satten GA, Critchley SE, Petersen LR, Dondero TJ. Guidelines for designing rapid assessment surveys of HIV seroprevalence among hospitalized patients. *Public Health Rep.* 1994; 109:53–59.

8. Jones JL, Hutto P, Meyer P, Dowda H, Gamble WB Jr, Gunn RA. HIV seroprevalence and reasons for refusing and accepting HIV testing. *Sex Transm Dis.* 1993;20:334–337.

9. Groseclose SL, Erickson B, Quinn TC, Glasser D, Campbell CH, Hook EW III. Characterization of patients accepting and refusing routine, voluntary HIV antibody testing in public sexually transmitted disease clinics. *Sex Transm Dis.* 1994;21:31–35.

10. Simon PA, Weber M, Ford WL, Cheng F, Kerndt PR. Reasons for HIV antibody test refusal in a heterosexual sexually transmitted disease clinic population. *AIDS.* 1996;10:1549–1553.

11. Paget WJ, Zwahlen M, Eichmann AR. Voluntary confidential HIV testing of STD patients in Switzerland, 1990–5: HIV test refusers cause different biases on HIV prevalences in heterosexuals and homo/bisexuals. *Genitourin Med.* 1997;73:444–447.

12. Alpert PL, Shuter J, DeShaw MG, Webber MP, Klein RS. Factors associated with unrecognized HIV-1 infection in an inner-city emergency department. *Ann Emerg Med.* 1996;28:159–164.

13. Kelen GD, Fritz S, Qaqish B, et al. Unrecognized human immunodeficiency virus infection in emergency department patients. *N Engl J Med.* 1988;318: 1645–1650.

14. *Care for Veterans With HIV Disease: Characteristics of Veterans in VA Care, Fiscal Year 2000–2001.* Palo Alto, Calif: US Department of Veterans Affairs; 2001.

15. *International Classification of Diseases, Ninth Revision.* Geneva, Switzerland: World Health Organization; 1980.

16. Dean AG, Dean JA, Coulombier D, et al. *Epi Info, Version 6: A Word Processing, Database and Statistics Program for Epidemiology on Microcomputers.* Atlanta, Ga: Centers for Disease Control and Prevention; 1994.

17. Niu MT, Bethel J, Holodniy M, Standiford HC, Schnittman SM. Zidovudine treatment in patients with primary (acute) human immunodeficiency virus type 1 infection: a randomized, double-blind, placebo-controlled trial. *J Infect Dis.* 1998;178:80–91.

18. Gandhi NSM, Gordon K, Concato J, Justice A. Delayed presentation for HIV care among veterans: an opportunity for intervention. Paper presented at: 13th Conference of Retroviruses and Opportunistic Infections; February 5–8, 2006; Denver, Colo.

19. Lindsay MK, Adefris W, Peterson HB, Williams H, Johnson J, Klein L. Determinants of acceptance of routine voluntary human immunodeficiency virus testing in an inner-city prenatal population. *Obstet Gynecol.* 1991;78:678–680.

20. Fehrs LJ, Hill D, Kerndt PR, Rose TP, Henneman C. Targeted HIV screening at a Los Angeles prenatal/ family planning health center. *Am J Public Health.* 1991;81:619–622.

21. Barbacci MB, Dalabetta GA, Repke JT, et al. Human immunodeficiency virus infection in women attending an inner-city prenatal clinic: ineffectiveness of targeted screening. *Sex Transm Dis.* 1990;17:122–126.

22. Brady KA, Berry S, Gupta R, Weiner M, Turner BJ. Seasonal variation in undiagnosed HIV infection on the general medicine and trauma services of two urban hospitals. *J Gen Intern Med.* 2005;20:324–330.